W measurements and prospects with ATLAS

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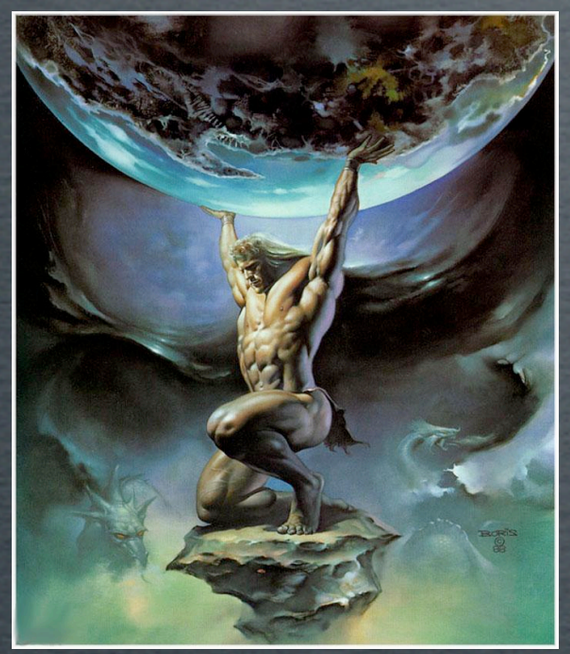


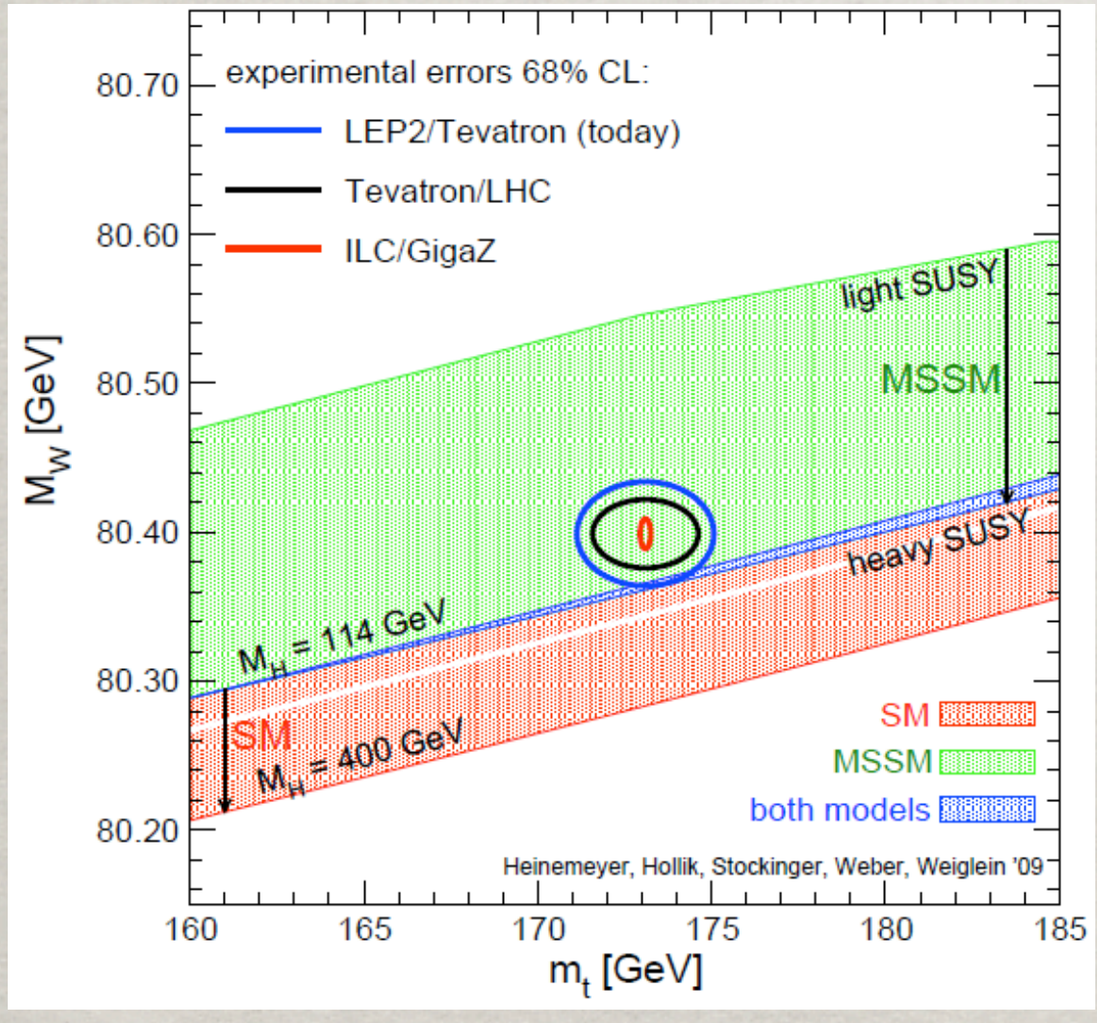
Outline

- Motivations
- Cross-Sections at 7 TeV and expected event yield
- Asymmetry Measurements
- W mass prospects
- First W results from ATLAS

Precision Electroweak

$$m_W = (\frac{\pi \alpha_{EM}}{\sqrt{2} G_F})^{\frac{1}{2}} \frac{1}{sin\theta_W \sqrt{1 - \Delta r}}$$

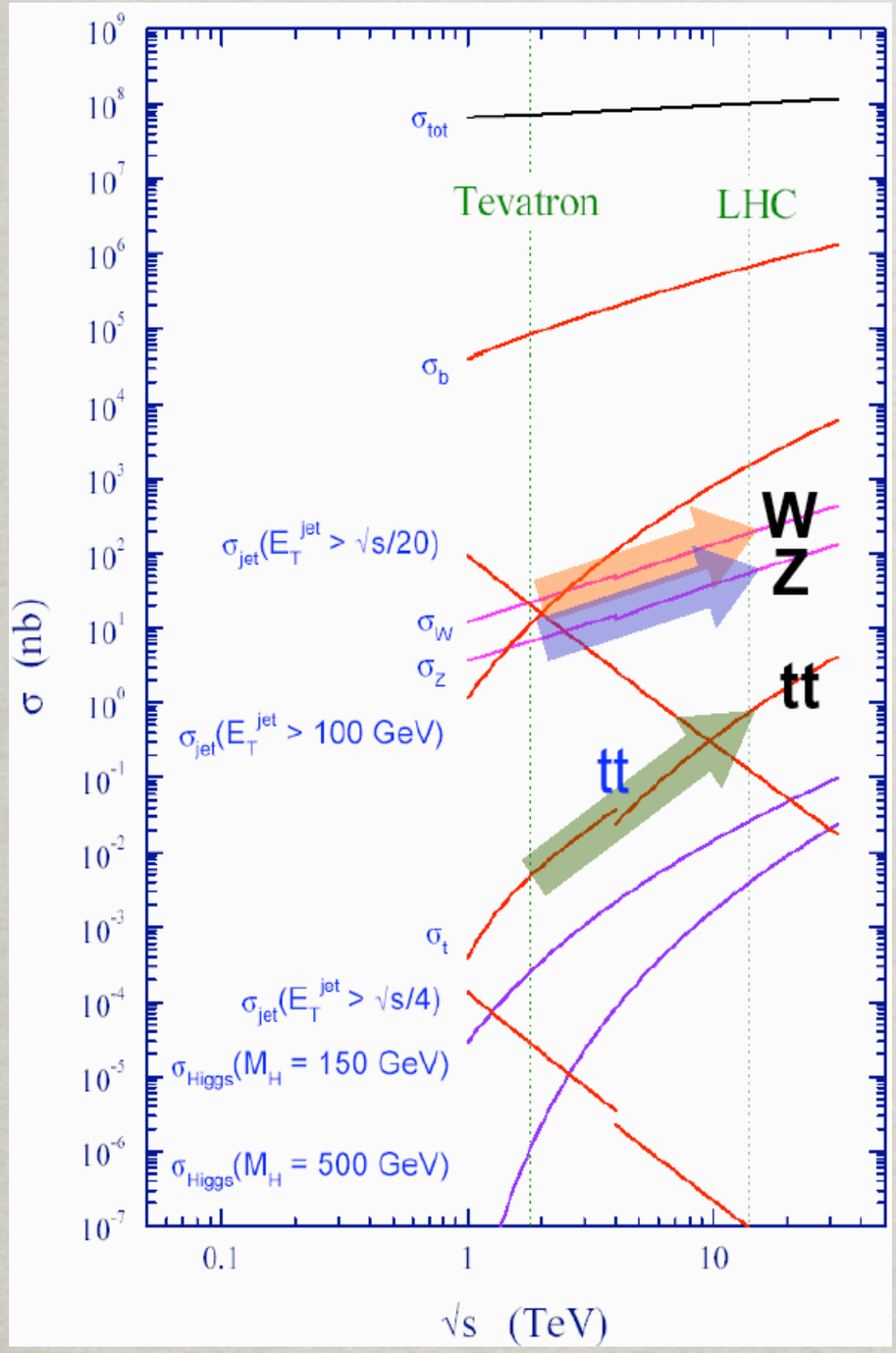
$$f(m_{top}^2, log m_h)$$



$$\Delta m_W \approx 0.7 \times 10^{-2} \Delta m_{top}$$

$$\Delta m_W \approx 10 \mathrm{MeV}$$

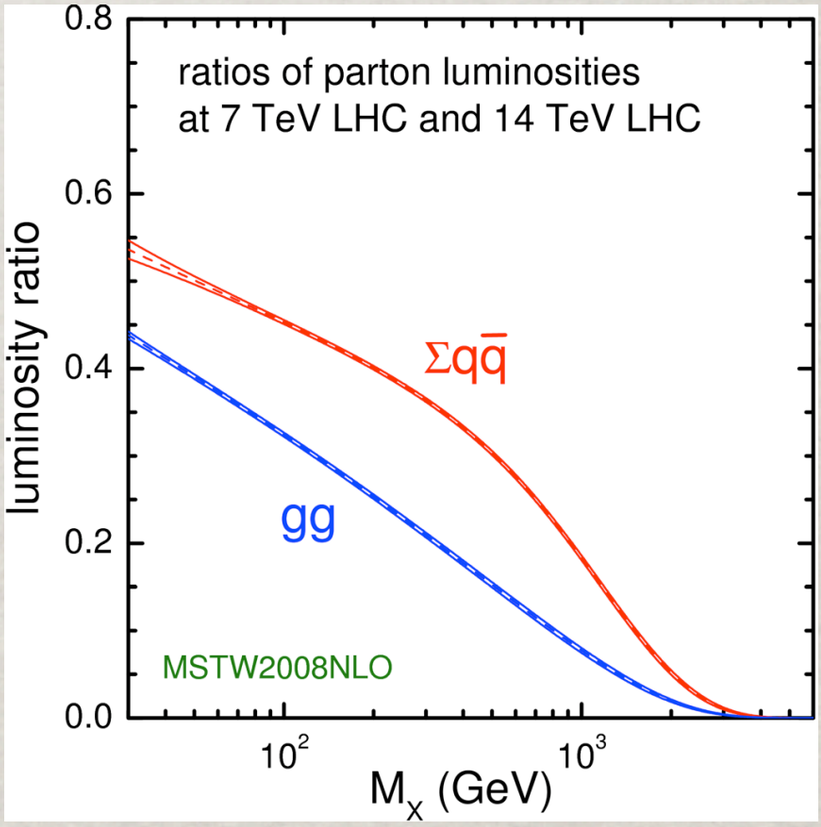
Expected Cross-Sections



At *7* TeV

$\sigma^{NNLO}(W \rightarrow l\nu) = 10.45$ nb

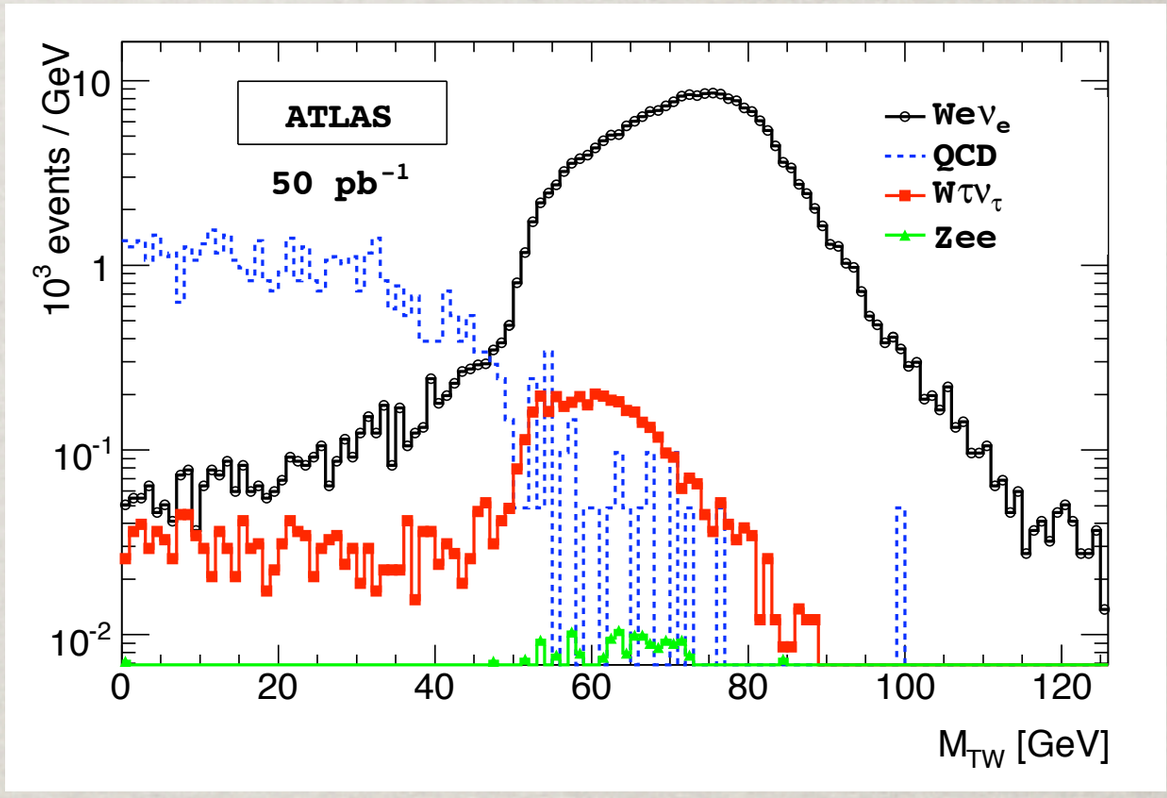
roughly x2 at *14* TeV



Cross-section Measurements

14 TeV

- P_T > 25 GeV lepton
- Missing Et > 25 GeV
- Expected uncertainty (stat+sys , no lumi):
  - ~5% after 50 pb^{-1}
  - ~2.5% after 1 fb^{-1}

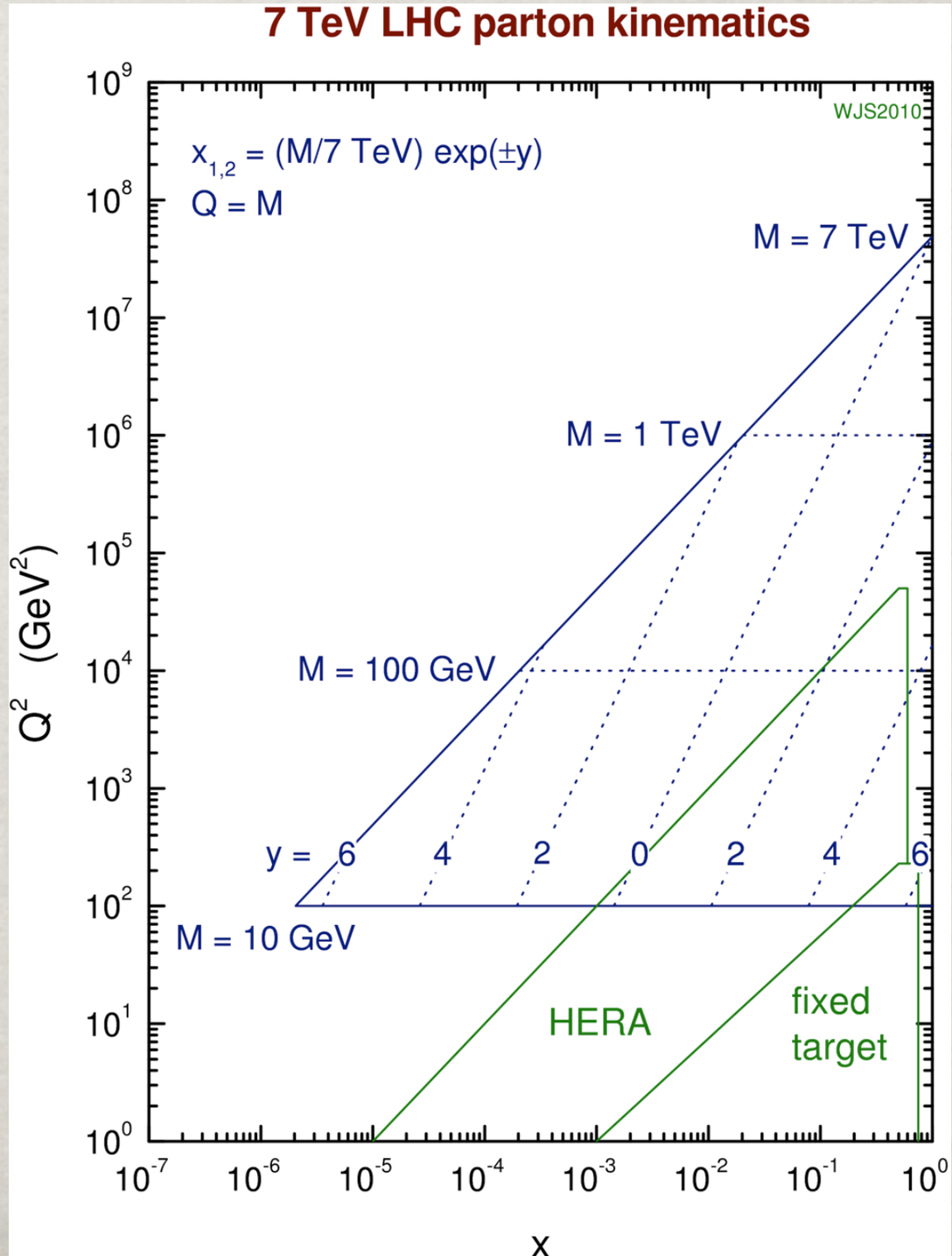


$$M_T = \sqrt{p_T^l E_T^{miss}(1 - cos\Delta\phi(p_T^l, E_T^{miss}))}$$

~factor of 2 less W's at 7 TeV

PDFs and constraints

- Electroweak physics most sensitive to low x partons at LHC
  - 10^{-4} to 0.1 for $|\eta| < 2.5$
- PDFs probed by W asymmetry at LHC



W-Asymmetry

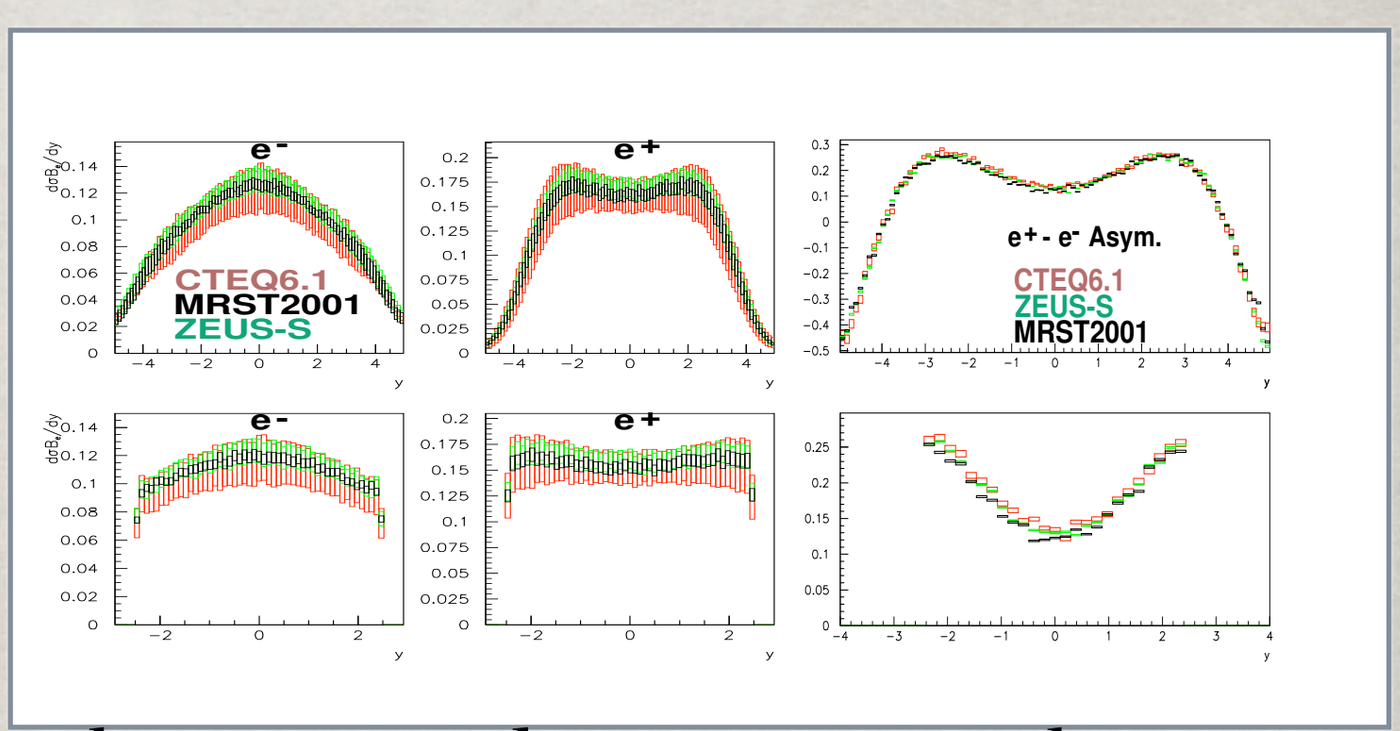
- Strong Asymmetry from production mechanism

$$A_W = \frac{d\sigma(W^+)/dy_{W^+} - d\sigma(W^-)/dy_{W^-}}{d\sigma(W^+)/dy_{W^+} + d\sigma(W^-)/dy_{W^-}}$$

W^+ production depends mainly on the $u(x)$ and $d(x)$ distributions,

W^- mainly on the $d(x)$ and $\bar{u}(x)$

- Very sensitive to PDF
- either use lepton asymmetry or reconstruct W

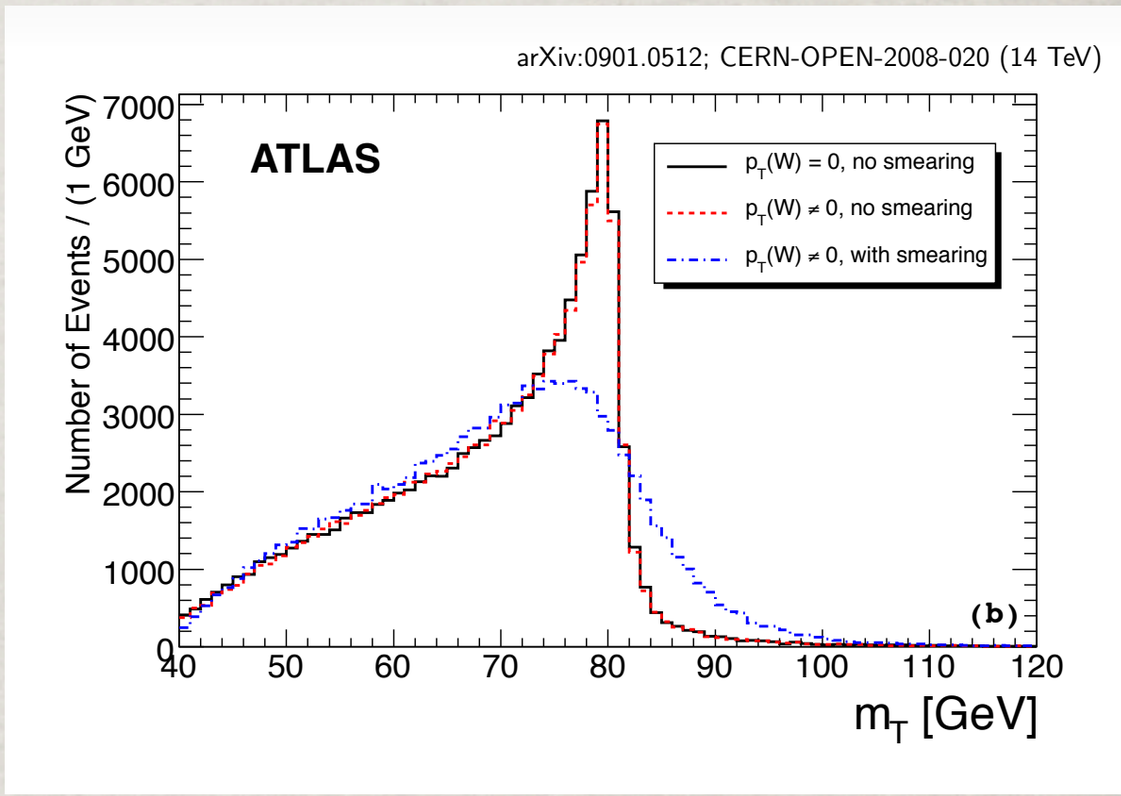


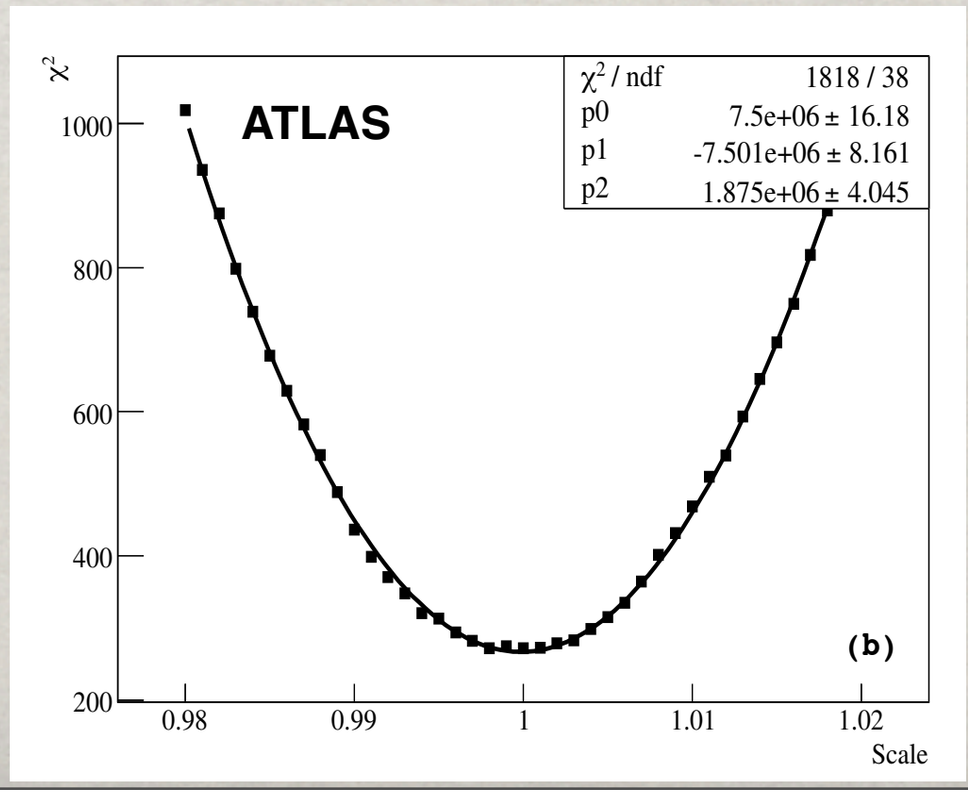
hope to reduce error on low x gluon distribution by~40%

W MASS PROSPECTS

- Two distributions (different systematics)
  - P_T lepton
  - M_T of W

$$\chi^2 = \sum_i \frac{(n_i^{obs} - n_i^{exp})^2}{\sigma_i^2}$$





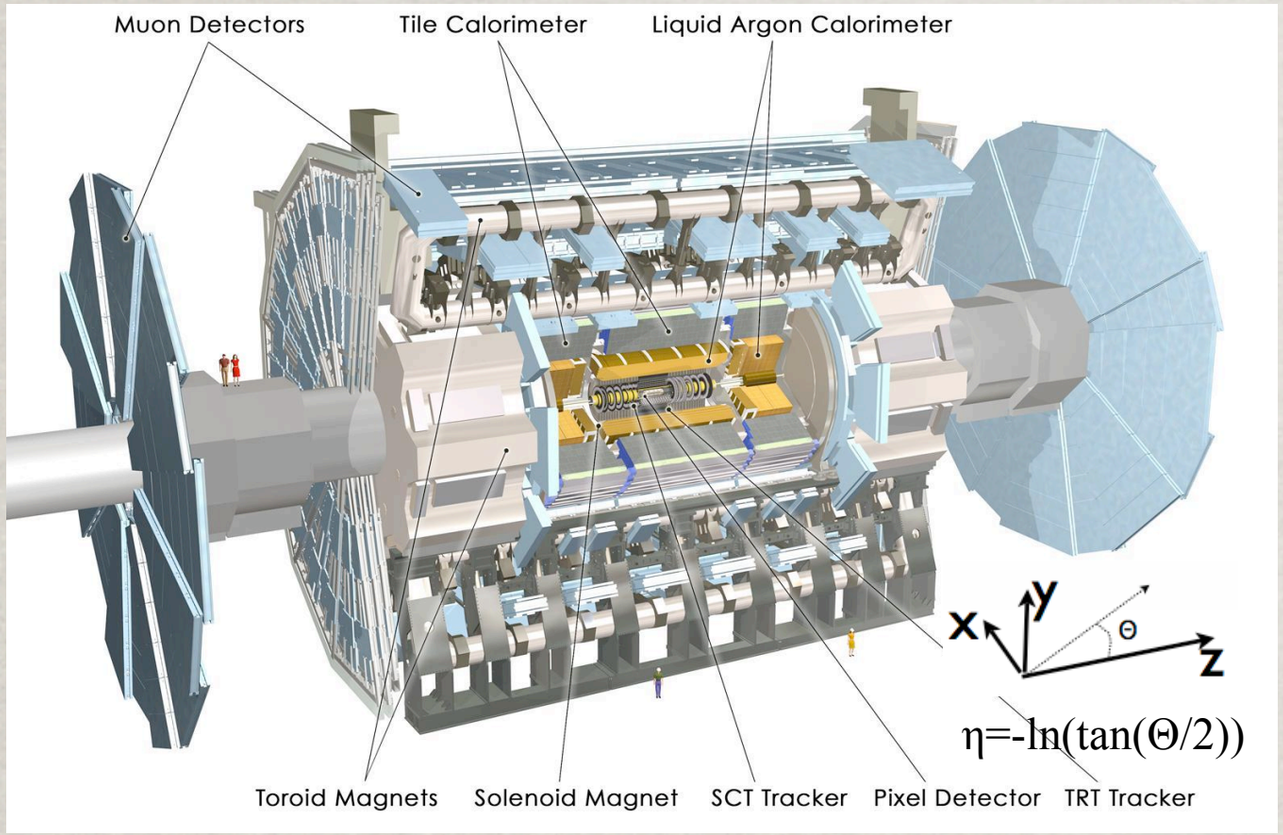
Systematics for early measurement

Method	p_T (e) [MeV]	p_T (μ) [MeV]	m_T (e) [MeV]	m_T (μ) [MeV]
δM_W (stat.)	120	106	61	57
δM_W (scale)	110	110	110	110
δM_W (resol)	5	5	5	5
δM_W (tails)	28	<28	28	<28
δM_W (eff.)	14	-	14	-
δM_W (recoil)	-	-	200	200
δM_W (bkg)	3	3	3	3
δM_W (PDF)	25	25	25	25

SN-ATLAS-2008-070

couple hundred MeV at 15pb^{-1}
< 10 MeV ultimate goal

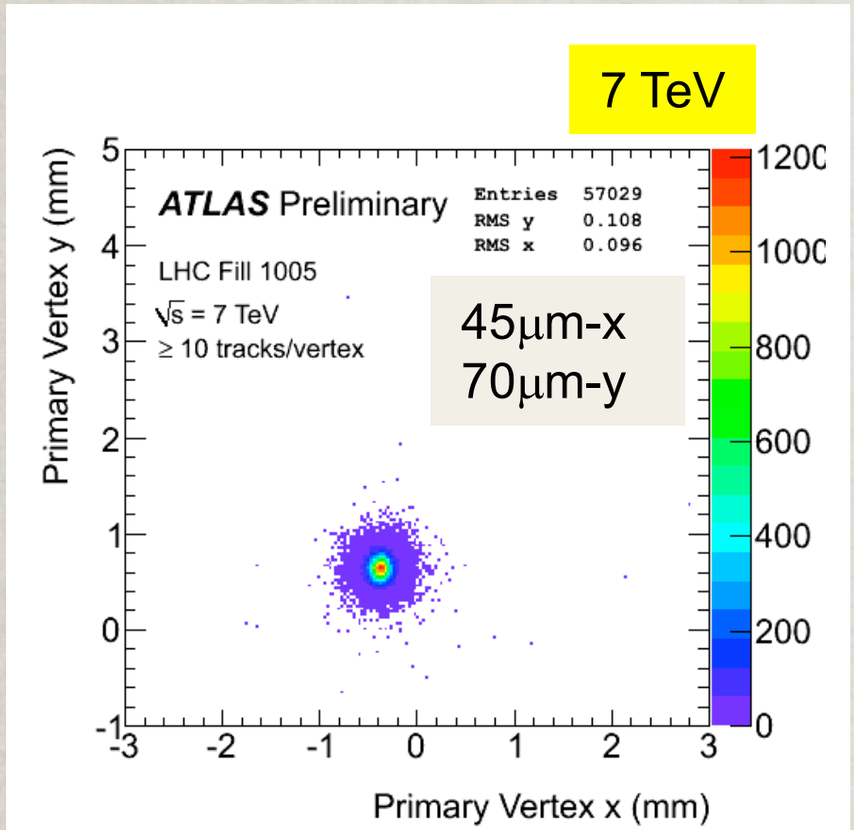
ATLAS STATUS

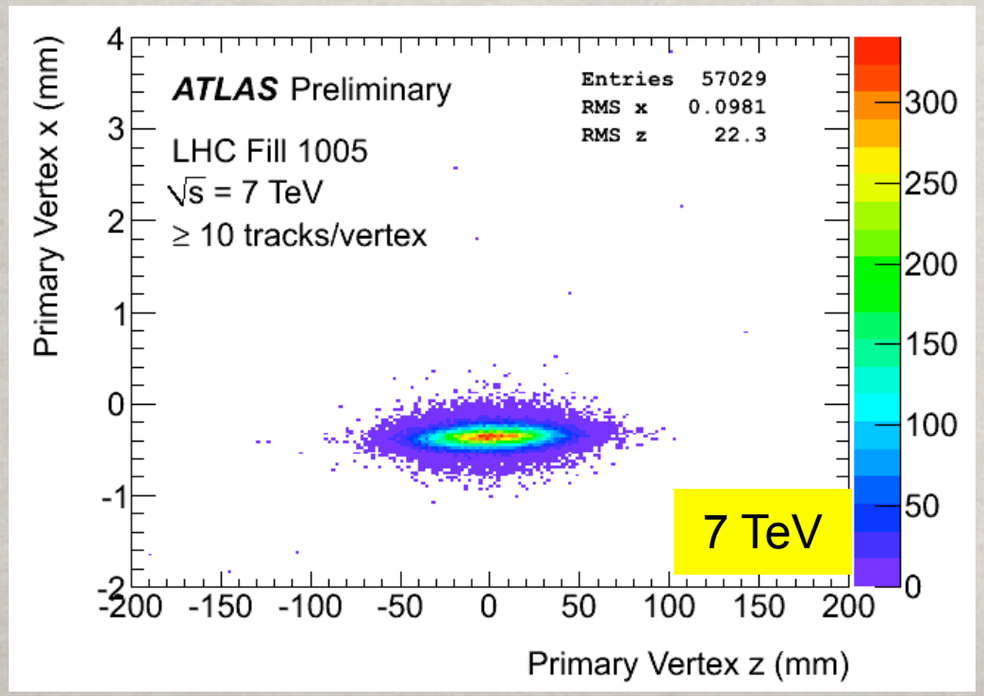


7000 Tons
25 m height
46 m length
0.1 billion channels

Detector	Channels	% Operational
Pixel	80 M	97.5%
SCT	6.3 M	99.3%
TRT	350 K	98%
Lar EM CAL	170 K	98.5%
Tile Cal	9800	97.3%
HEC	5600	99.9%
Forward LAr	3500	100%
Calo Trigger	7160	99.8%
muon RPC Trigger	370K	99.7%
muon TGC Trigger	320K	100%
MDT	350 K	99.7%
CSC	31 K	98.5%
RPC	370 K	97.3%
TGC	320 K	98.8%

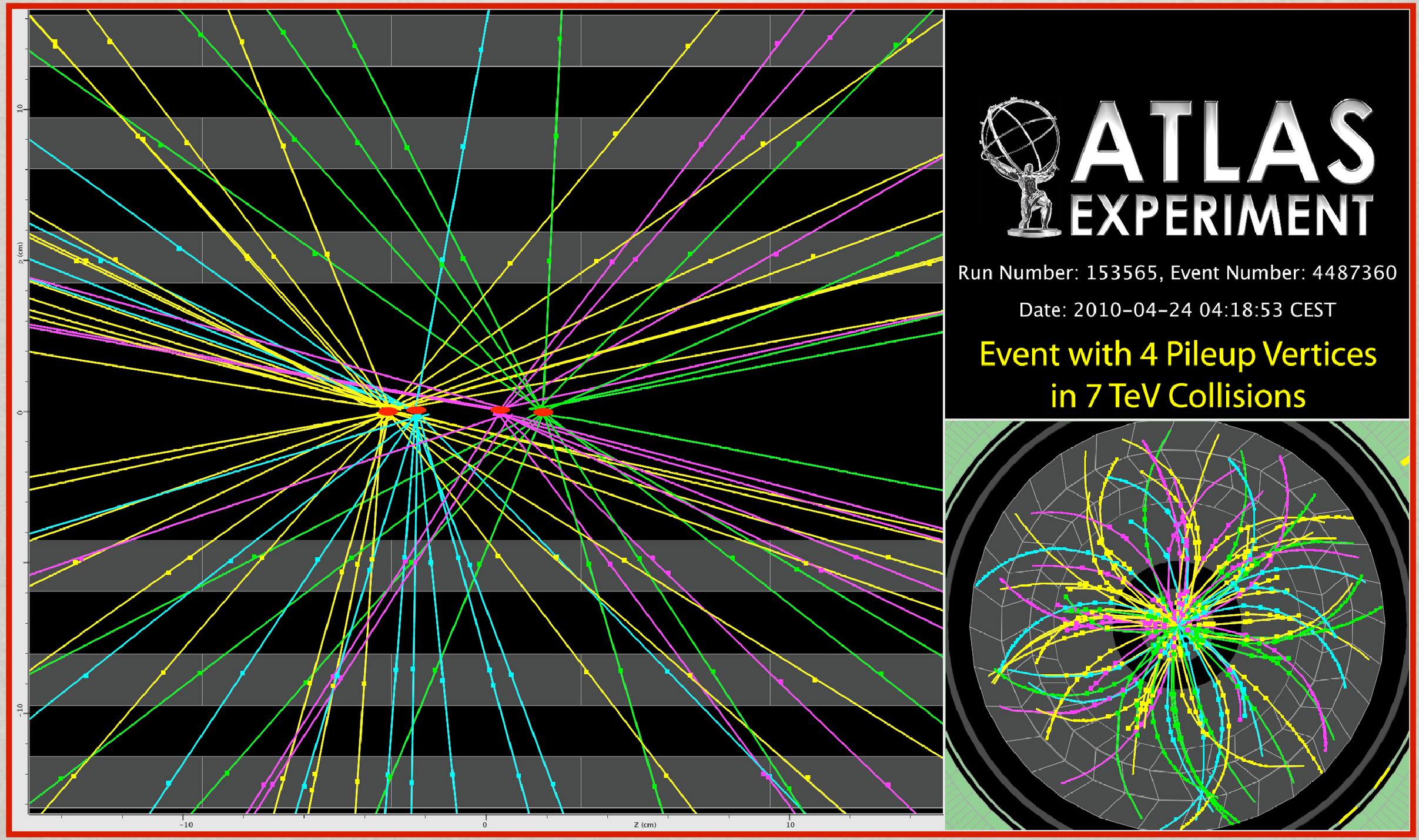
Beam Conditions





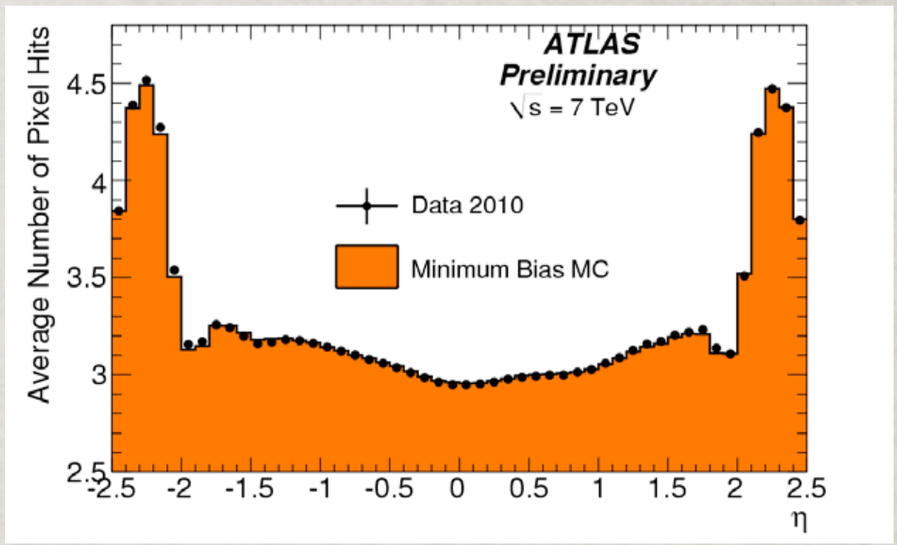
- very stable beam conditions within fill
- some pileup events already!

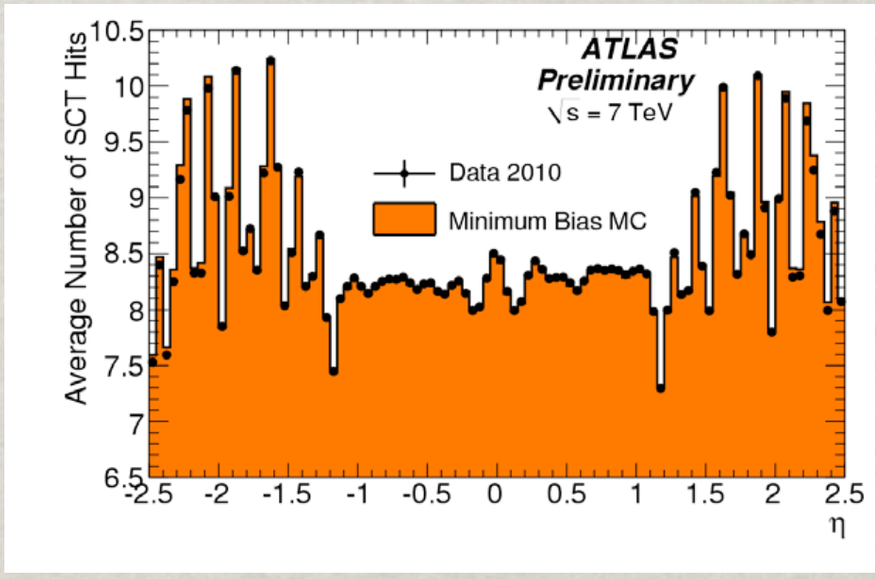
Multi-vertex event



Tracking comparisons

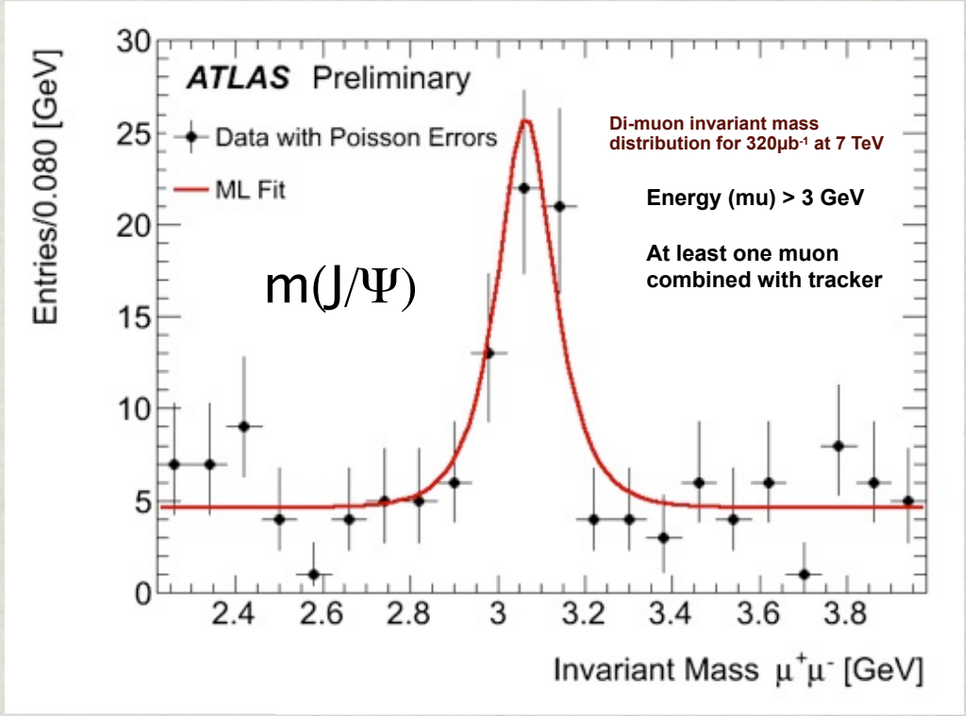
- Excellent description of ID, material, beam spot
- dn/dη paper at 900 GeV accepted
- 7 TeV paper in the works

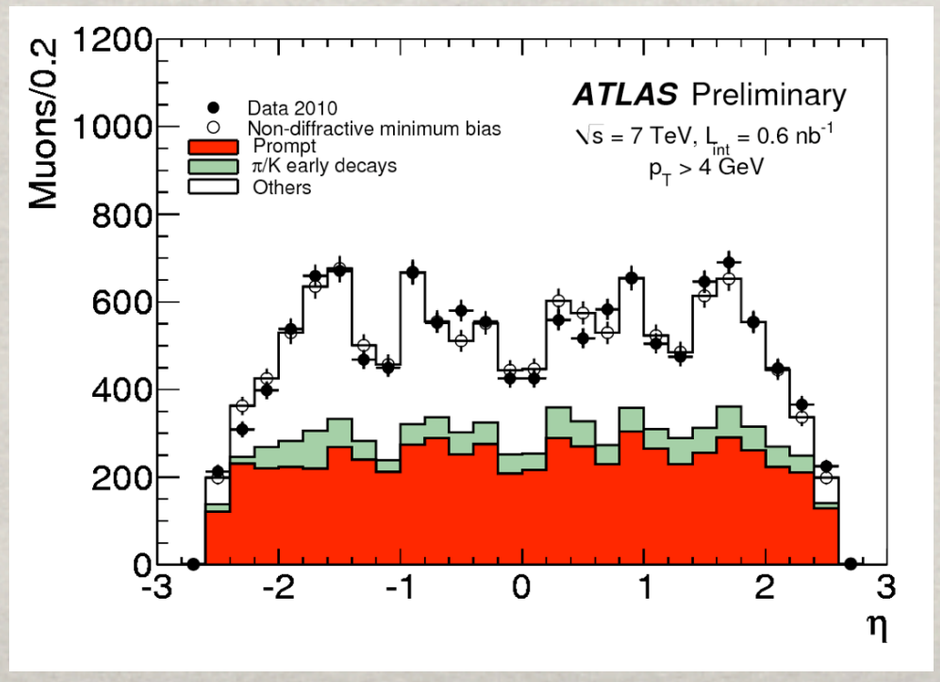


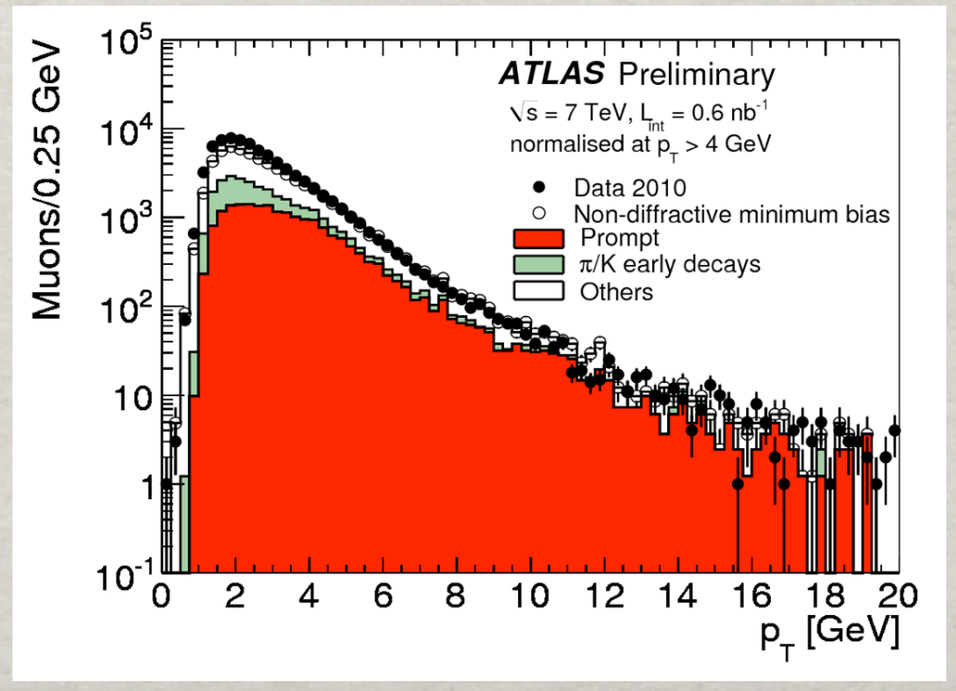


Muon Performance

- J/ψ→μμ observed
- good description of inclusive muon spectra

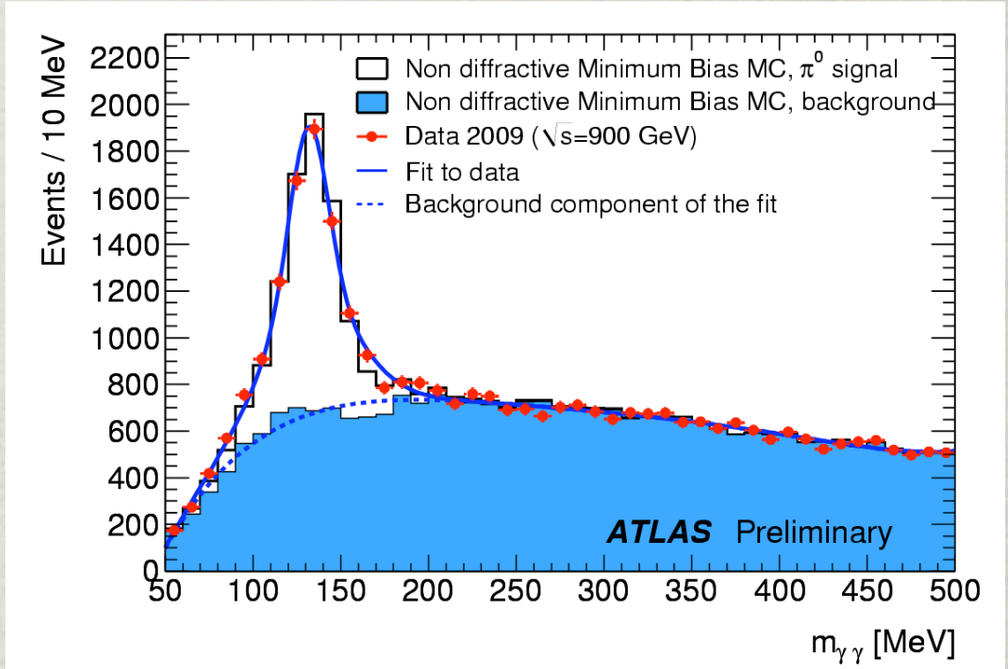


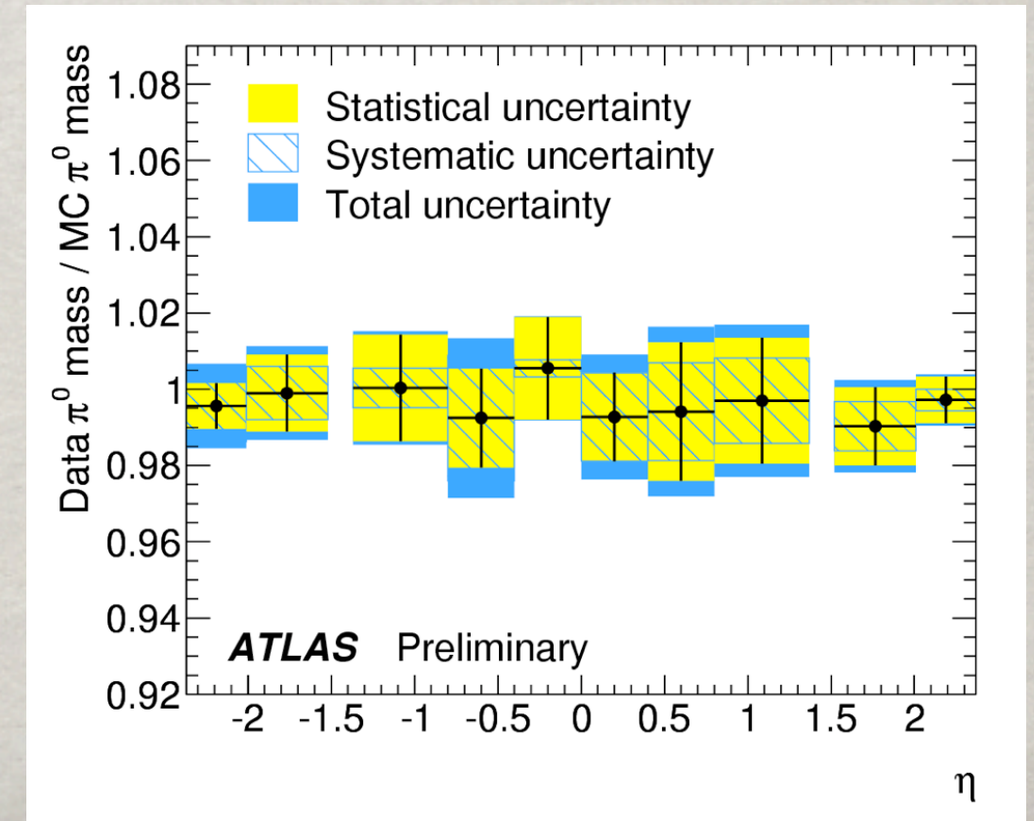




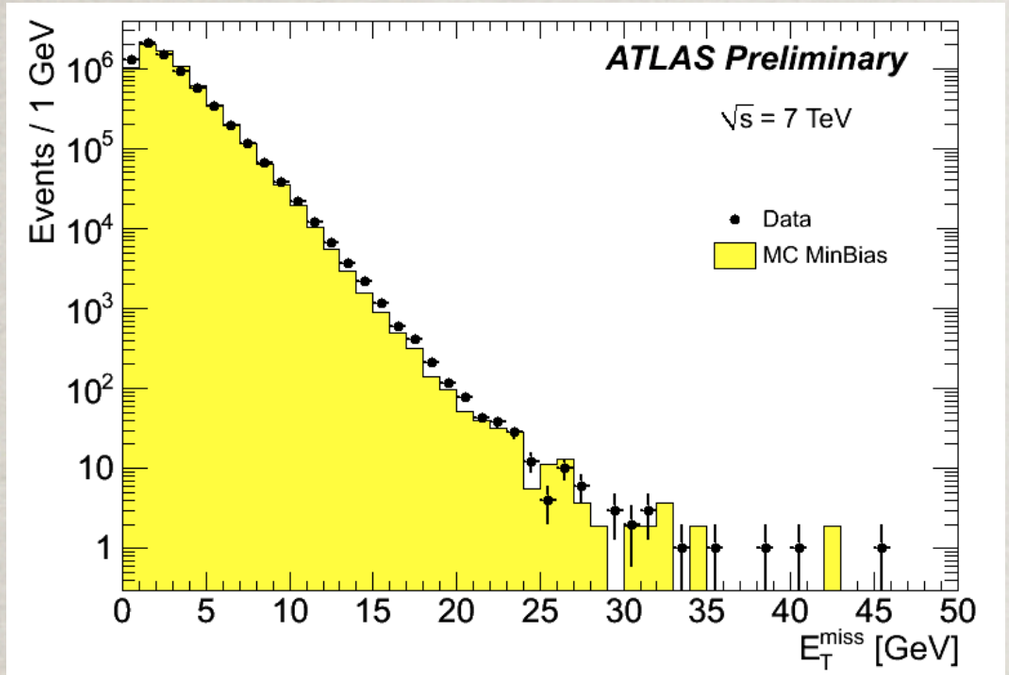
Electron/Photon performance

- Excellent description of data
- On the way to in-situ calibration with SM resonances
- 11 μb^{-1} of data

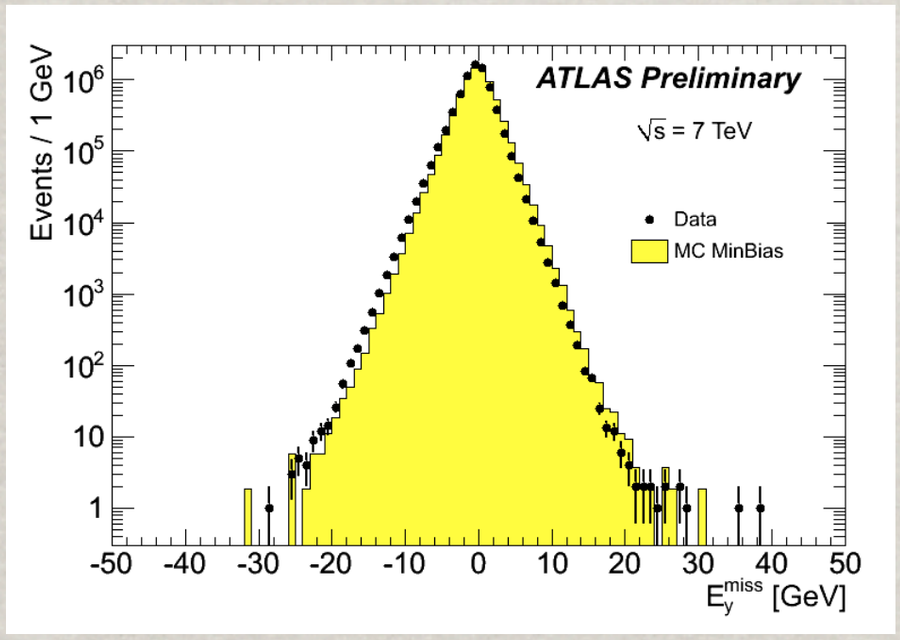


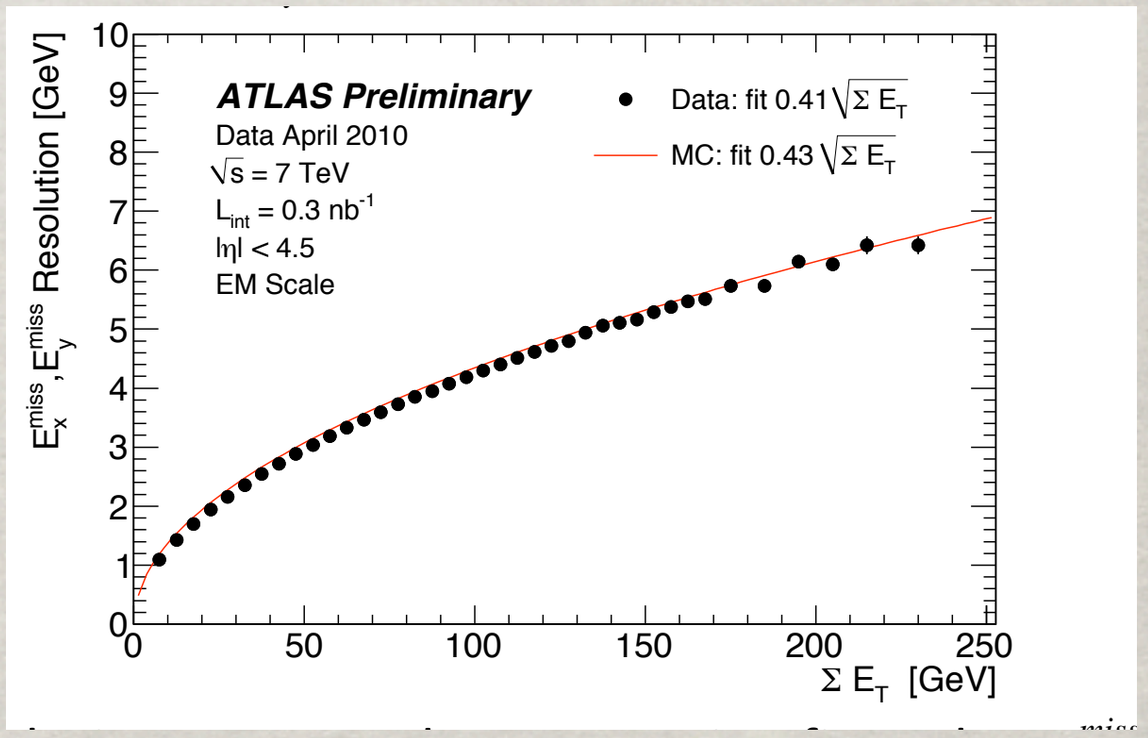


Missing ET



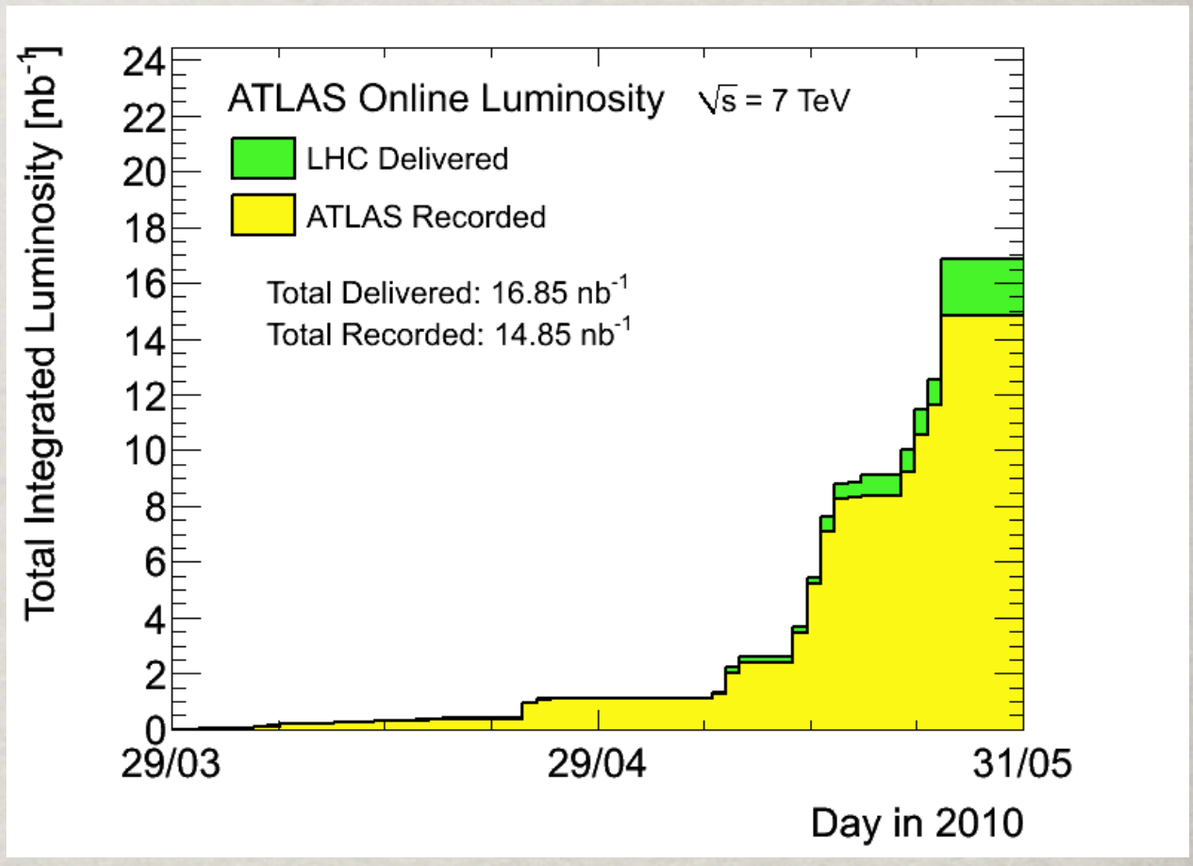
- Excellent agreement with min bias data
- Evaluated at EM scale



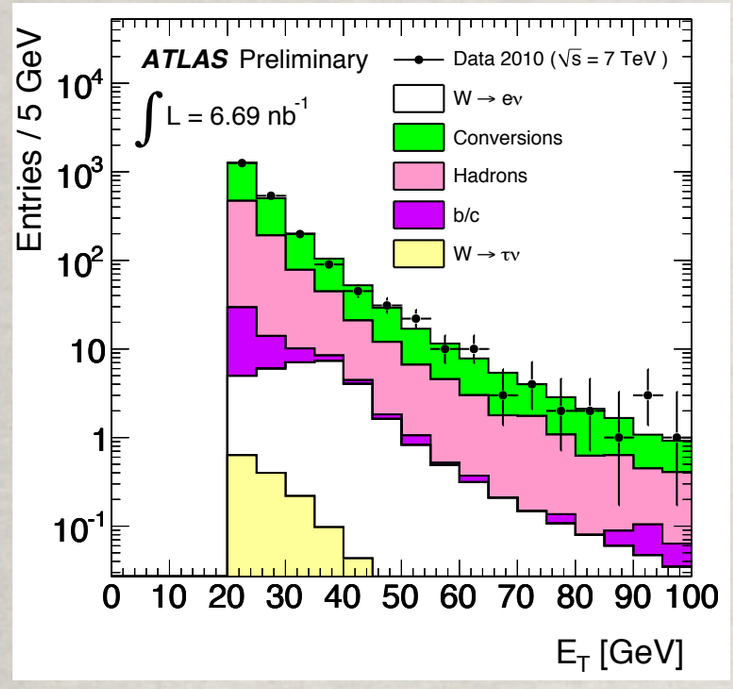


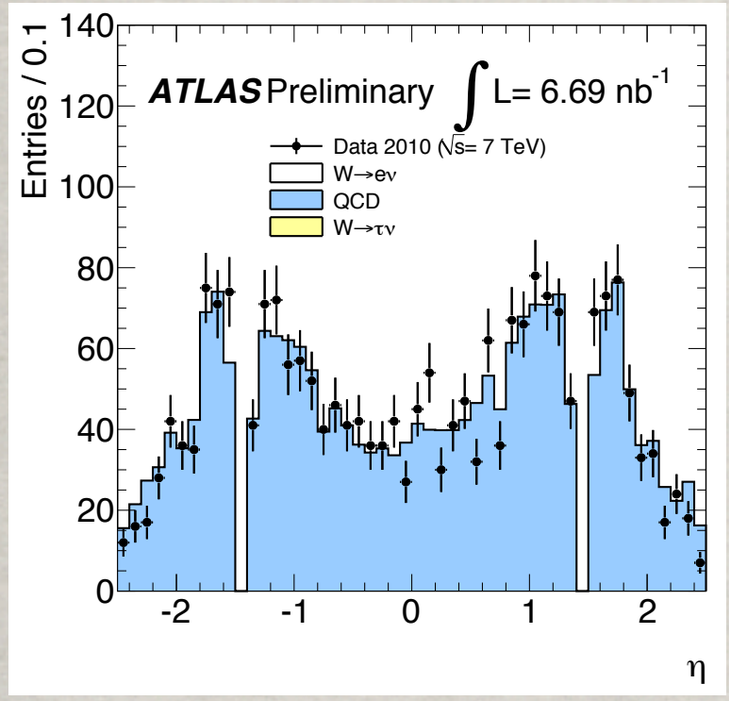
Observation of W

- Preselection
  - Electron/Muon
  - MET
- Background Estimation
- Candidates and Properties



Electron

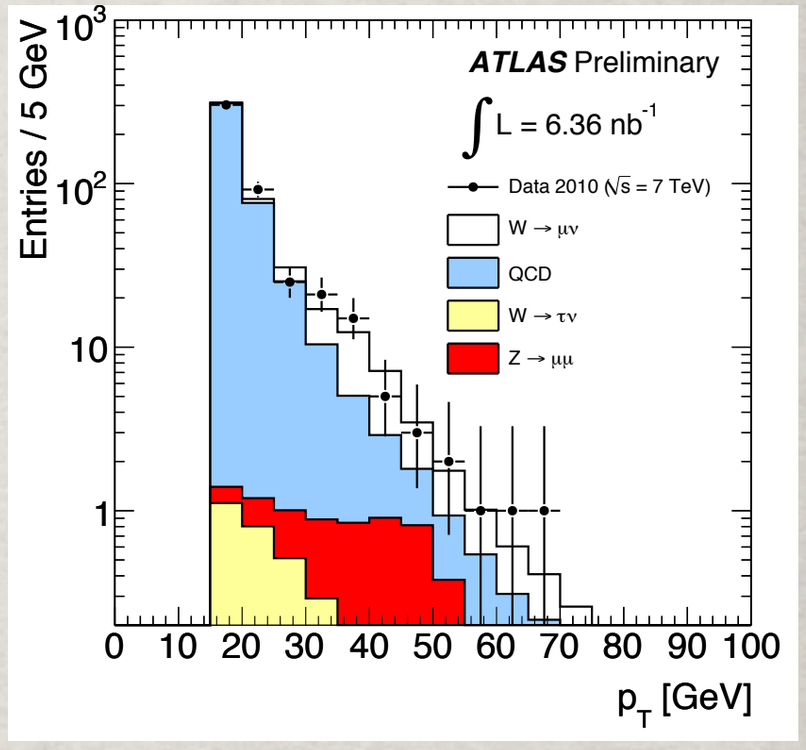


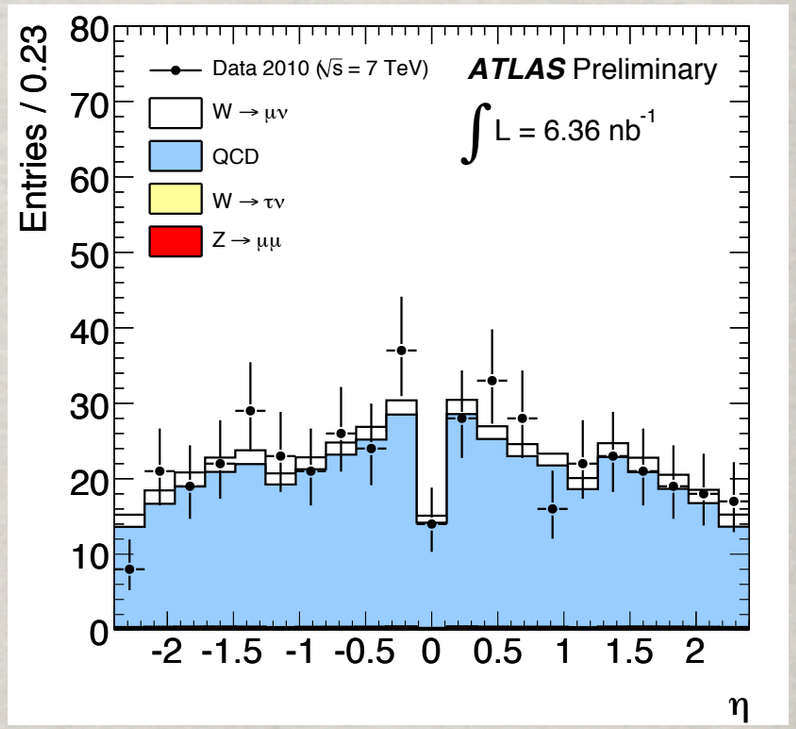


- Loose EM Cluster with $E_T > 20$ GeV
- $|\eta| < 2.47$
- $1.37 < |\eta| < 1.52$
- Background normalized to data (factor of ~2.2)
- Preselection dominated by multijet production

Muon Preselection

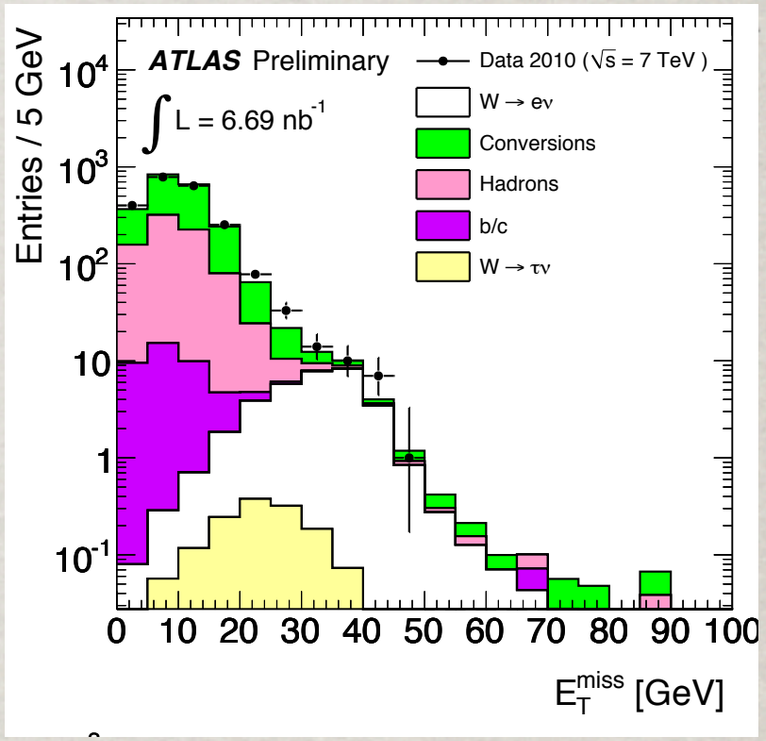
- Combined muon
  - P_T > 20 GeV
  - P_T (MS)> 10 GeV
  - $|Z_0 - Z_{PV}| < 1$ cm
- Background MC normalized to data (factor of 1.9)

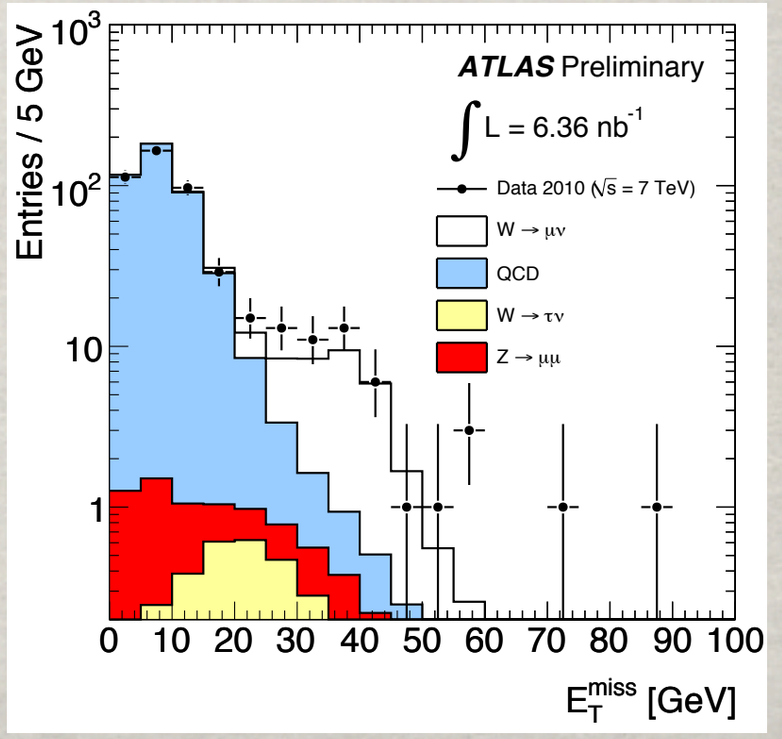




Missing Energy

- Based on topological clusters
- Evaluated at the electromagnetic energy scale
- Important in the muon case is the correction from the muon!



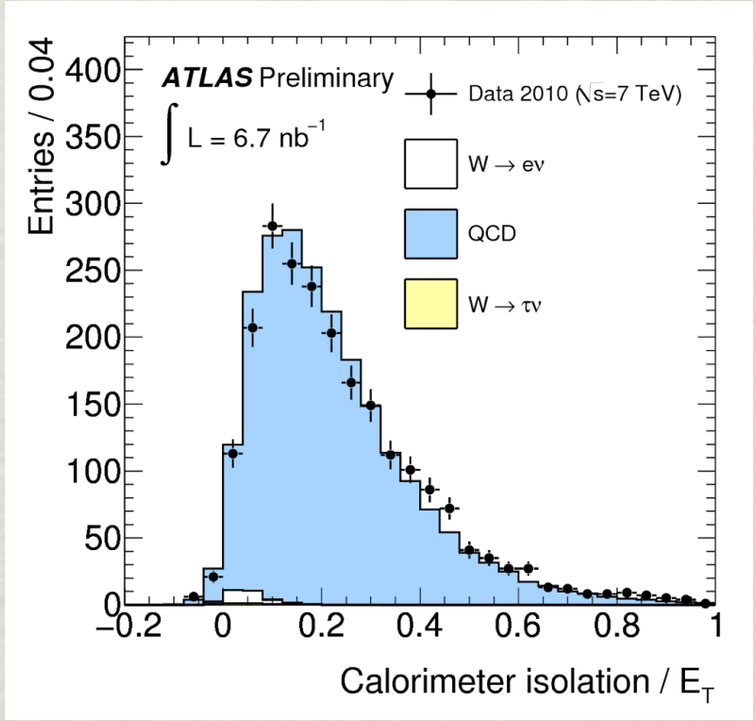


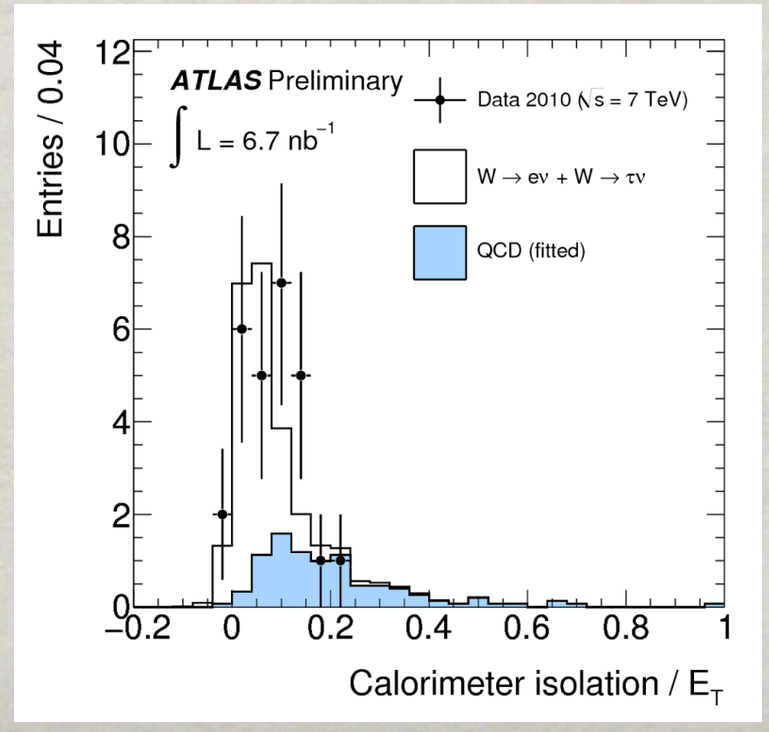
Background Estimation electrons

- Isolation in cone of $\Delta R = 0.3$ from MC templates for signal and background

- Fit in both background and signal dominated region for fraction of dijets/W

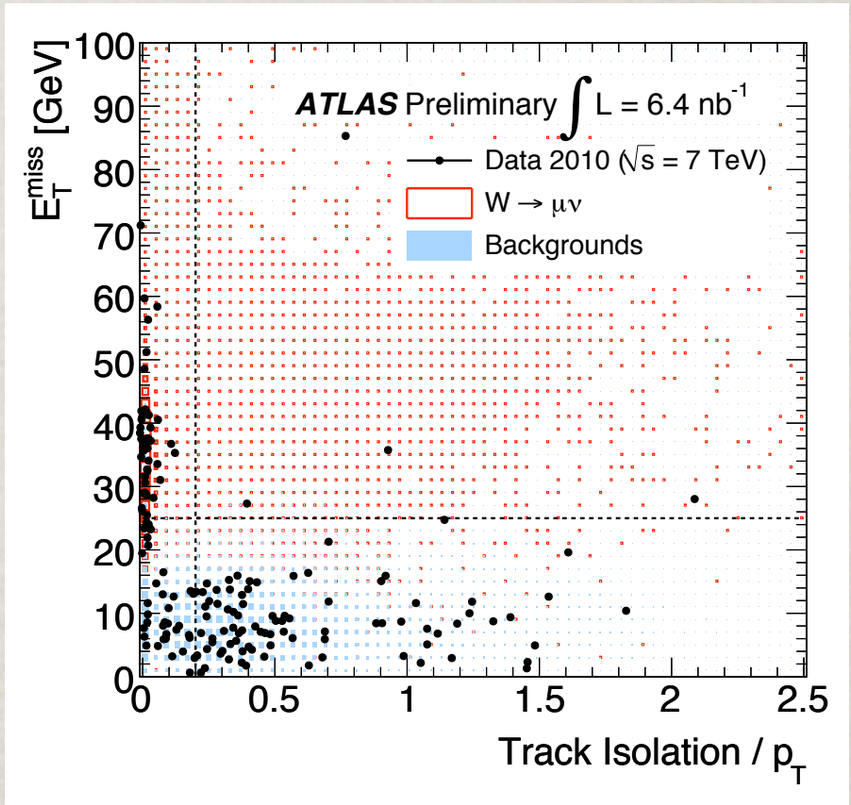
$$N_{QCD} = 2.0 \pm 1.2(stat) \pm 0.4(syst)$$





Background estimation Muons

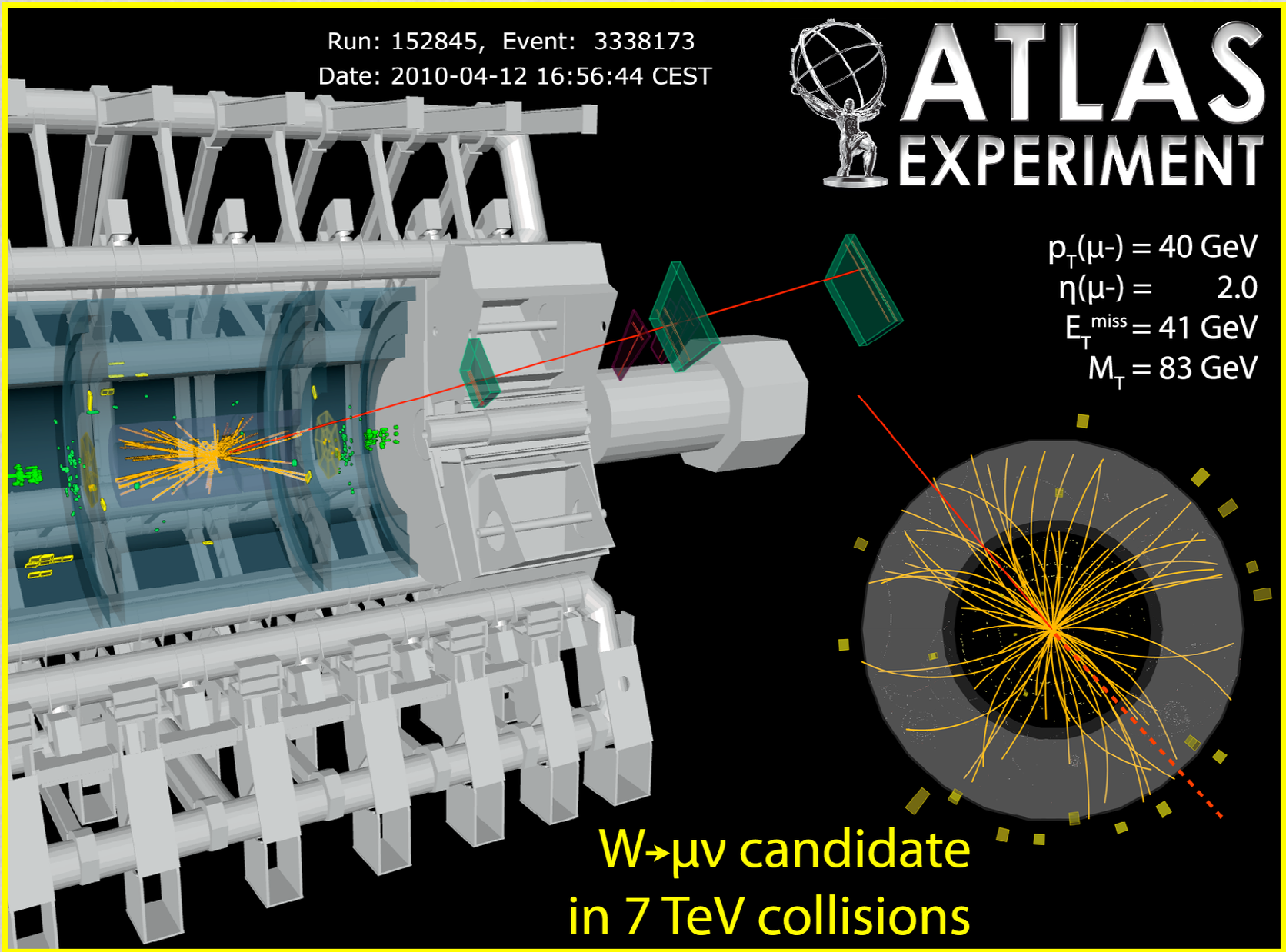
- ABCD method (assuming uncorrelated variables)
- Systematic from residual correlation and MC/Data differences



Background Estimation

$1.0 \pm 0.5(\text{stat}) \pm 0.7(\text{syst})$

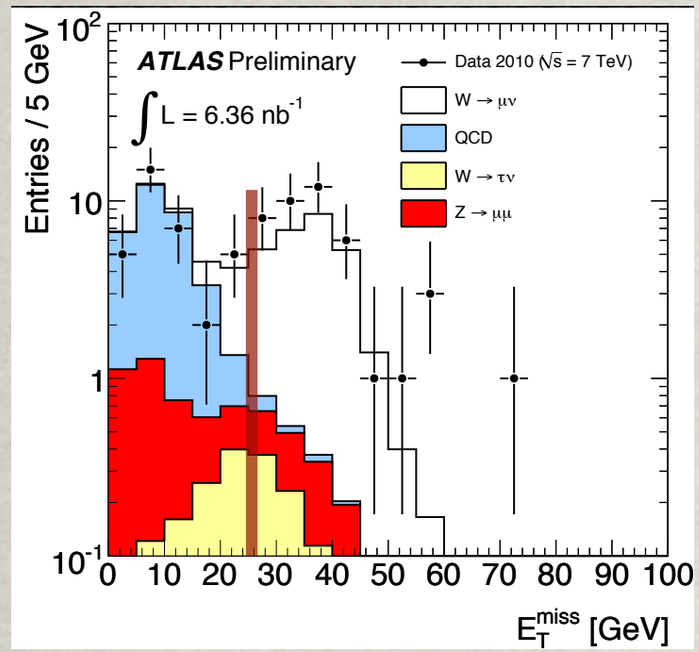
W→μν Event



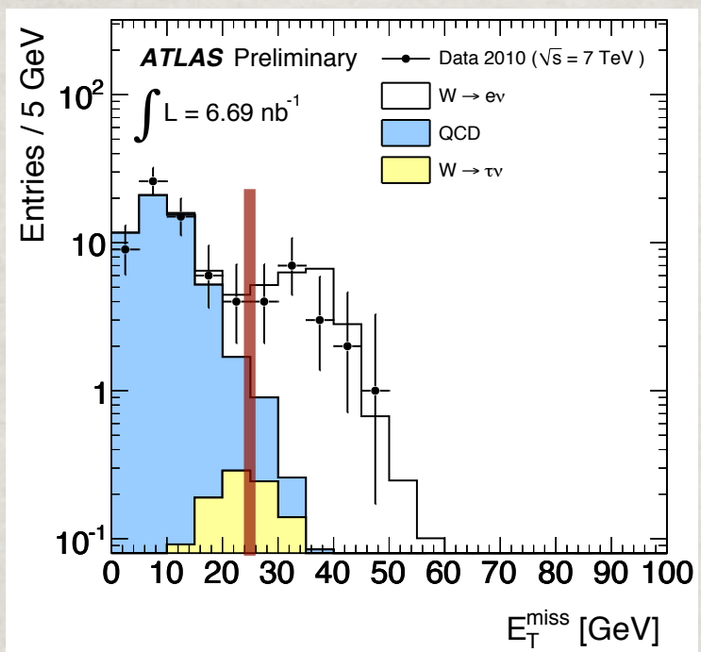
Muon: 3 Pixel hits, 8 SCT hits, 17 TRT hits, 14 MDT hits, Z~0.1 mm from vertex, ID-MS matching within 1 GeV, E_T^{miss} (calorimeter only) ~ 3 GeV

Tight Selection

Muons



Electrons



Missing E_T > 20 GeV

Transverse Mass > 40 GeV

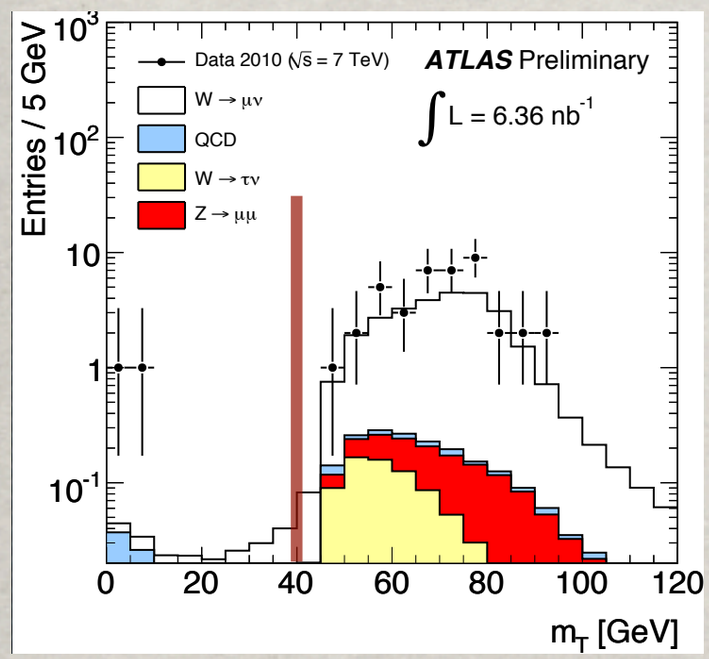
Tighter electron selection

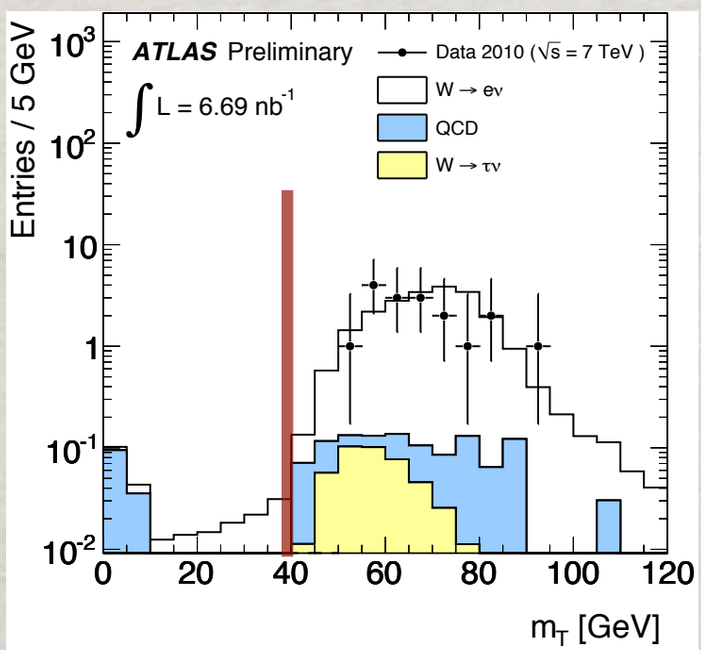
Isolated Muon

Observe

17 Electron Events

40 Muon Events

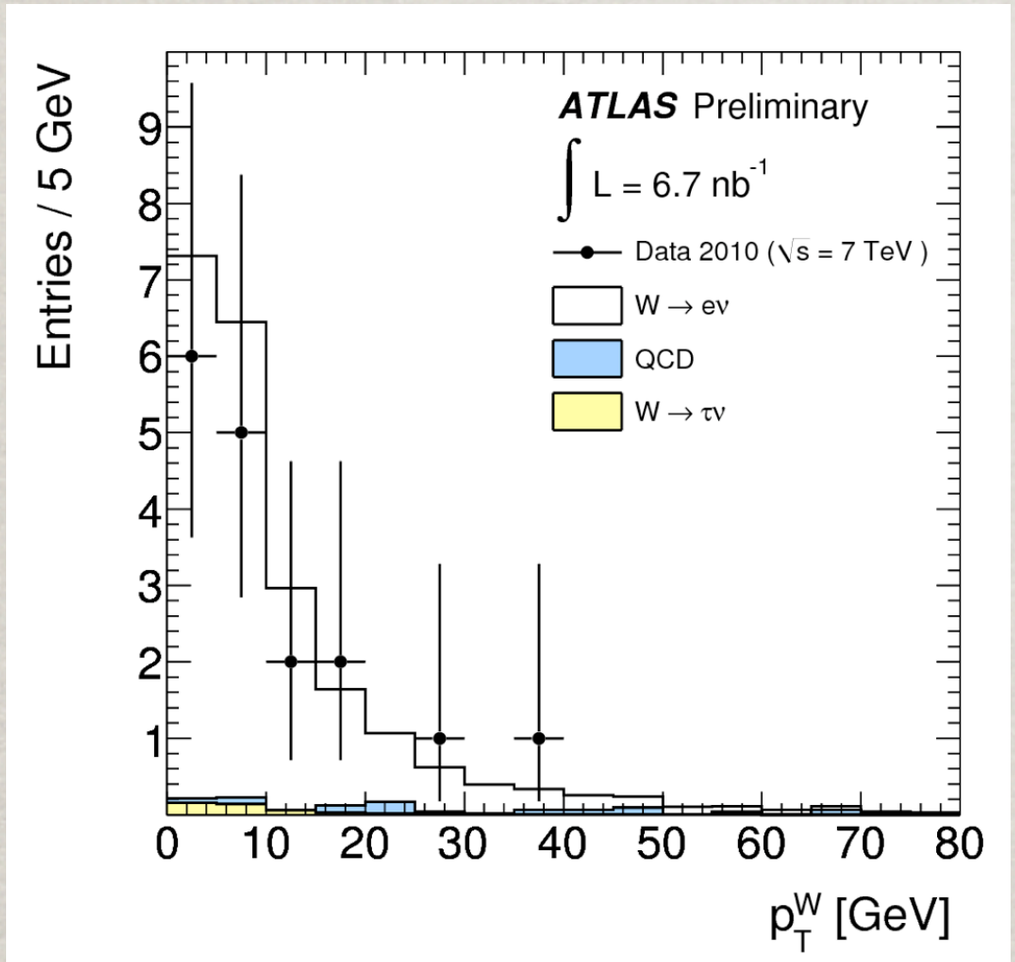


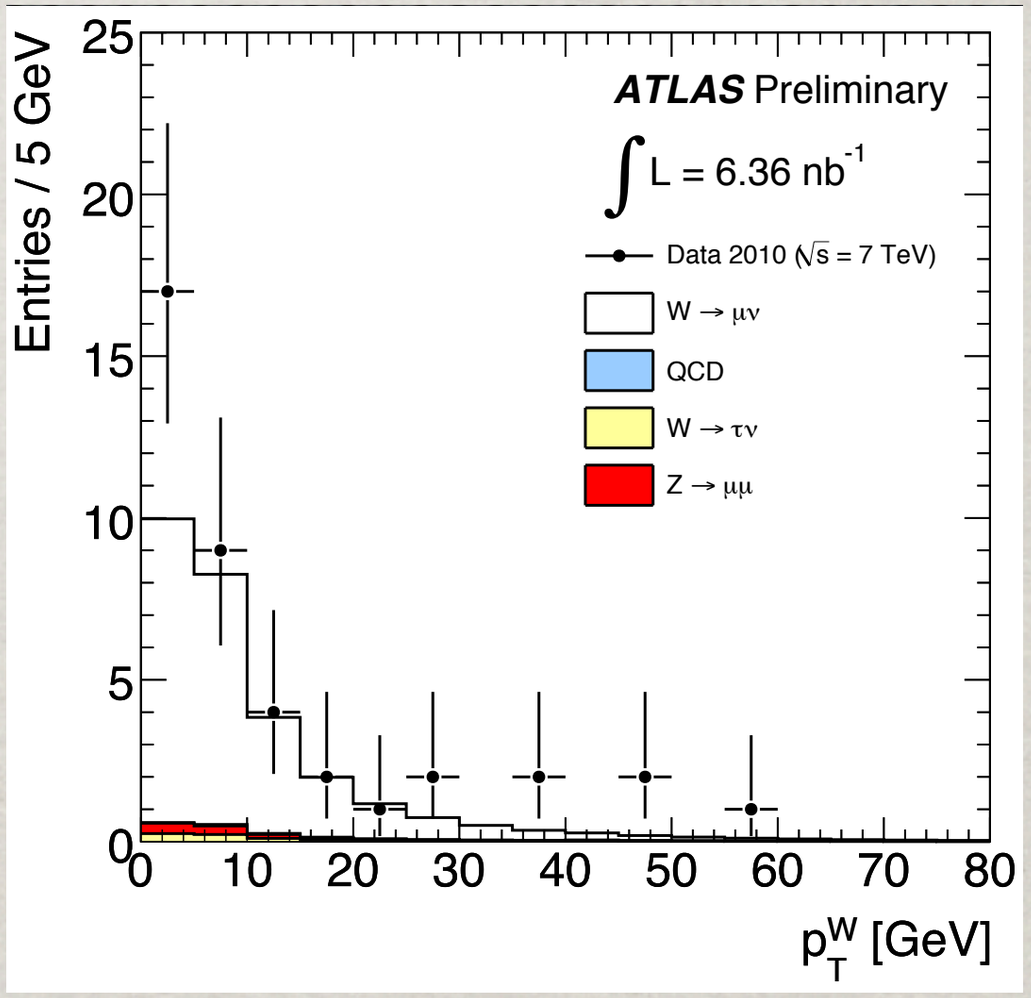


W Expectations

	Electrons	Muons
Signal	20.7±1.7(syst)±4.5(lumi)	25.9±3.6(syst)±5.2 (lumi)
Background	2.0 ±1.2(stat)±0.4(syst)±0.2 (lumi)	2.8±0.5 (stat)±0.8(syst)±0.6 (lumi)
Total Expected	22.7±1.2(stat)±1.7(syst) ±4.5(lumi)	28.7±0.5(stat)±3.9 (syst)±5.7 (lumi)
Observed	17	40

Properties of W Candidates



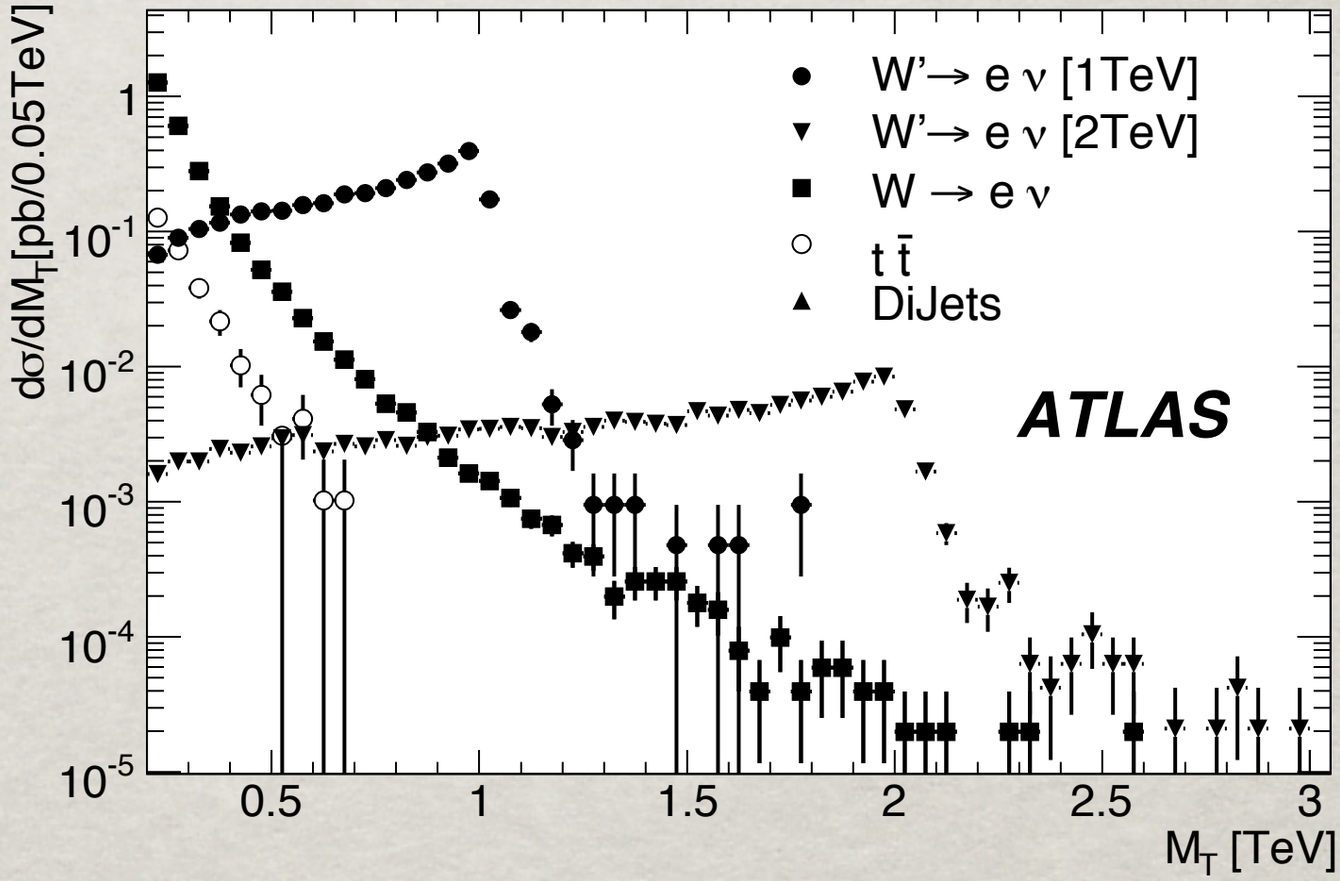


New Physics?

At 14 TeV,
at 7 TeV cross-sections down by ~4

- Even at 7 TeV we begin getting sensitivity over Tevatron at low luminosity

- Stay tuned!



Summary

- LHC will offer unprecedented number of W's for a variety of studies:
  - Detector Commissioning
  - Precision Electroweak Physics
  - Backgrounds for 'new' physics
- Just getting started but excellent early results